Programme Information & PLOs

This document forms part of the Programme Design Document and is for use in the roll-out of the York Pedagogy to design and capture new programme statement of purpose (for applicants to the programme), programme learning outcomes, programme map and enhancement plan. Please provide information required on all three tabs of this document.

Title of the new programme – including any year abroad/ in industry variants

MSci & BSc Natural Sciences specialising in Physics

Level of qualification

Please select:	Level 7	

Please indicate if the programme is offered with any year abroad / in industry variants	**Year in Industry** Please select Y/N	Yes
	Year Abroad Please select Y/N	Yes

Department(s):
Where more than one department is involved, indicate the lead department

Lead Department	Natural Sciences
Other contributing Departments:	Physics, Biology, Chemistry, Mathematics

Programme leadership and programme team

Please name the programme leader and any key members of staff responsible for designing, maintaining and overseeing the programme.

Jason Levesley (Ch. BoS), Roddy Vann (Prog. Director), Eric Dykeman (Maths), Andy Parsons & Glenn Hurst (Chem), Laurence Wilson (Phys), Gareth Evans (Biol)

Particular information that the UTC working group should be aware of when considering the programme documentation (e.g. challenges faced, status of the implementation of the pedagogy, need to incorporate PSRB or employer expectations)

With few exceptions the modules which make up any of the Nat Sci programmes are drawn from the corresponding contributing single subject degree programmes. Local pedagogical practices and modes of assessment are honoured in Nat Sci unless there is evidence that such practices would not be pedagogically sound. Therefore, given the nature of the Nat Sci programmes parts of this document draw liberally from, or make reference to, the corresponding documentation from the contributing departments. This documentation should therefore be considered in parallel with the corresponding proforma for the single subject degree programmes of the contributing departments.

Who has been involved in producing the programme map and enhancement plan? (please include confirmation of the extent to which colleagues from the programme team /BoS have been involved; whether student views have yet been incorporated, and also any external input, such as employer liaison board)

The people listed in item 14 have primarily being responsible for the programme map and enhancement plan. At all stages the BoS has had free access to and being invited to comment on the documentation. Student input has been fed into the YP process in a focus group, through the SSLC and via the BoS.

Purpose and learning outcomes of the programme

Statement of purpose for applicants to the programme

Please express succinctly the overall aims of the programme as an applicant facing statement for a prospectus or website. This should clarify to a prospective student why they should choose this programme, what it will provide to them and what benefits they will gain from completing it.

All Natural Science programmes at the University of York aim to produce leaders in science, technology and industry who will have the interdisciplinary knowledge and skills to succeed in complex research and business environments. You will learn how science is conducted in different disciplines, how to operate within different methodological communities, and how to apply techniques and ideas across multiple disciplines.

As a Natural Science student specialising in Physics you will spend the majority of your time studying in the Department of Physics, an ambitious and inclusive department that will challenge your understanding of physics and support your desire to explore the fundamental building blocks of the universe and technological society. You will have access to world-leading experts and cutting-edge equipment to support your quest for understanding. By completing your chosen programme, you will learn to appreciate the intellectual beauty, societal purpose, and wider applications of physics and science in general, and become inspired for a lifetime of learning and exploration. Not only will you become a true physicist, you will have experienced first hand the links that exist between Physics and other sciences that you study in your first two years at York. This will give you a unique cross-disciplinary perspective.

The three key tenets of your Physics education are experiment, theory and computation and all will be developed during your studies, culminating in the final year project. This provides opportunities for you to develop strong practical, organisational, and communication skills, and provides you with all the abilities and approaches you will need for future careers.

As a student on the MSci programme you will achieve all the above, but your skills will be developed even further and to a deeper level as you undertake an extended final year research project that will move you towards the research frontier in Physics, giving you the expertise, skills and experience necessary to pursue graduate level research in Physics both within and outside academia.

Programme Learning Outcomes

Please provide six to eight statements of what a graduate of the programme can be expected to do.

Taken together, these outcomes should capture the distinctive features of the programme. They should also be outcomes for which progressive achievement through the course of the programme can be articulated, and which will therefore be reflected in the design of the whole programme.

PLO	On successful completion of the programme, graduates will be able to:
1 BSc	Assess and evaluate problems in science, providing solutions through the application of physics, mathematics and/or computational knowledge and techniques.
1 MSci	Apply independent learning strategies that incorporate core and advanced physics, mathematics and/or computational knowledge, techniques and understanding to synthesise and evaluate real-world problems that require expertise in physics.
2 BSc	Construct and execute a scientific investigation using the principles of physics in investigating a hypothesis, and interpret outcomes.
2 MSci	Plan and execute an extended or complex scientific investigation using the principles of physics in investigating a hypothesis, and interpret outcomes in physical problems.
3 BSc	Interact and collaborate effectively within groups applying physics themes and concepts as appropriate for the interdisciplinary nature of a Natural Science degree, to open-ended problems.
3 MSci	Work independently and within a research team and apply group-specific research methodologies, including objective analysis and constructive criticism of research level literature, to extended or complex open-ended problems.
4 BSc	Communicate the integration and inter-relation of physics from the perspective of a Natural Scientist with interdisciplinary awareness, present sophisticated concepts and defend outcomes of physical studies succinctly in both written and oral formats to audiences in a logical way.
4 MSci	Communicate succinctly to the general public, scientists and professional physicists through accurate and precise scientific record keeping, scientific report writing and presentations.
5 BSc	Use of appropriate digital technologies in data handling and understand the wider applications of these techniques in quantitative science.
5 MSci	Select and apply sophisticated digital tools for in-depth scientific investigation and in wider societal applications
6 BSc	Use physics principles, themes, concepts and methodologies as appropriate to a Natural Scientist with an understanding of the possibilities that exist to exploit the synergies between physics and other science based disciplines as underpinned by experience and exposure to different scientific disciplines.
6 MSci	Use advanced physics principles, themes, concepts and methodologies as appropriate to a Natural Scientist with an understanding of the possibilities that exist to exploit the synergies between physics and other science based disciplines as underpinned by experience and exposure to different scientific disciplines.
7 BSc	

7 MSci	
8 BSc	
8 MSci	

Programme Learning Outcome for year in industry (where applicable)
For programmes which lead to the title 'with a Year in Industry' – typically involving an additional year – please provide either a) amended versions of some (at least one, but not necessarily all) of the standard PLOs listed above, showing how these are changed and enhanced by the additional year in industry b) an additional PLO, if and only if it is not possible to capture a key ability developed by the year in industry by alteration of the standard PLOs.

PLO7 Articulate how a physics-trained individual and physics approaches can contribute to successful industrial, commercial and/or non-academic environments.

Programme Learning Outcome for year abroad programmes (where applicable)
For programmes which lead to the title 'with a Year Abroad' – typically involving an additional year – please provide either a) amended versions of some (at least one, but not necessarily all) of the standard PLOs listed above, showing how these are changed and enhanced by the additional year abroad or b) an additional PLO, if and only if it is not possible to capture a key ability developed by the year abroad by alteration of the standard PLOs.

PLO7 Be inspired by and articulate the advantages of successfully study in a non-UK academic environment and how this broadens your perspective and develop adaptability, flexibility, resilience and drive.

Explanation of the choice of Programme Learning Outcomes
Please explain your rationale for choosing these PLOs in a statement that can be used for students (such as in a student handbook). Please include brief reference to:

i) Why the PLOs are considered ambitious or stretching?

To fully meet the PLOs given a student will need to meet the PLOs commensurate with those of a single subject physicist whilst studying upto two other sciences in Stages 1 & 2. This will ensure that a Nat Sci physicist has all the expertise of a single subject student in the type of physics most appropriate to interdisciplinary science, all backed up by first hand experience of other sciences and how physics is used across subject boundaries.

ii) The ways in which these outcomes are distinctive or particularly advantageous to the student:

As stated in the Physics single subject programme information: "Modules often use a common set of skills (e.g. algebraic, numerical, computational techniques for example) to address problems in specific topics. Seeing similar techniques in different contexts strengthens a student's knowledge of the technique, showing the power of the approach and its adaptability to many situations. The PLOs are clearly characteristics a Physicist should have and are distinct from the characteristics of students from other disciplines."
The PLOs above will ensure that a Nat Sci physicist has all the expertise of a single subject student in the type of physics most appropriate to interdisciplinary science, backed up by first hand experience of other sciences in Stages 1 & 2 and how physics is used across these subject boundaries.

iii) How the programme learning outcomes develop students' digital literacy and will make appropriate use of technology-enhanced learning (such as lecture recordings, online resources, simulations, online assessment, 'flipped classrooms' etc)?

As a Natural Science student who specialises in Physics spends the majority of their time studying physics it is natural that such a student will develop the digital literacy skills embedded in the various Physics programmes which include "The use of computing threads the degree at all levels encompassing programming (e.g. Python), instrument control (e.g. LabVIEW), digital measurement, data analysis (e.g. Origin, Excel) as well as report writing (e.g. Word, LaTeX) and presentations (e.g. PowerPoint, PDF). All our modules utilise the VLE (Yorkshare) with some modules using electronic question banks and videoed tutorials. All modules are 'opt-out' for audio-projector-capture using the Replay system. Where the equipment exists, the [physics] Department uses video capture to augment the audio-projector-capture systems to record blackboard and overhead projector.". Exposure to other departmental practices in Stages 1 & 2 will further enhance the digital literacy experience for a Natural Sciences Physics student as they experience the added ways in which such departments thread digital literacy through their programmes.

iv) How the PLOs support and enhance the students' employability (for example, opportunities for students to apply their learning in a real world setting)?
The programme's employability objectives should be informed by the University's Employability Strategy:

http://www.york.ac.uk/about/departments/support-and-admin/careers/staff/

All the Nat. Sci. programmes have been designed with employability in mind. This is not only as a factor of the design of the programmes themselves, which have had engagement with the University's employability strategy as a given since the early design phases of the programme. But also as a factor of the embedded skills that the contributing departments have built into their modules. Modules which form the bulk of the teaching on this degree programme. Many of the skills listed in the PLOs are generic and will equip the student with a highly transferrable skill set. As an example: PLOs 1 & 5 revolve around such transferrable skills as programming, communication skills and data analysis techniques which are applicable beyond the problems addressed in the programme.

vi) How will students who need additional support for academic and transferable skills be identified and supported by the Department?

Students who need support will generally self identify at admission or early in the Stage 1 and standard University protocols will then be followed. If this isn't the case and a student is identified as needing extra support later in the programme then the student will discuss the matter with their personal supervisor who will advise in accordance with University guidance. Students are assigned a supervisor in one of the contributing departments and have access to a subject facilitator in both contributing departments. The student can approach their supervisor for advice in accordance with University guidelines and seek more specialist advice on a particular discipline from the subject facilitator. Module level issues are handled with the department to which the module belongs and a student can avail themselves off all feedback and quality control mechanisms that the department offers.

vii) How is teaching informed and led by research in the department/ centre/ University?

The lead department in this degree programme is the Physics department where most of your classification bearing modules will be taken. This is an edited version of their statement: "The Department undertook a major Programme Review in 2015/16. The review considered all taught materials in the Natural Sciences (pathways Biology-Chemistry-Physics and Chemistry-Maths-Physics) aligning the early stages of each programme to the Institute of Physics core material, and ensuring that this delivers to all students the necessary prerequisites to study in-depth modules at Stage 4. These in-depth Stage 4 modules are inspired by and/or centred on the research interests of our academic staff. This design ensures that by the end of Stage 3 all students are exposed to the key ideas of each of our research groups. Further, the Department has refreshed its teaching laboratories to ensure a modern laboratory (experimental, astrophysics or computational) experience that enhances the taught parts of the programme. The Programme Review ensured each student undertakes a significant final year project. These projects are taxing requiring students to draw on and apply the breadth of training provided throughout their programme. They also expose many (particularly in Stage 4) to the research methodologies of specific disciplines within the physics department and beyond."
You will also benefit from early exposure to teaching in at least two other research active departments, one of which will be the Chemistry department.

Stage-level progression

Please complete the table below, to summarise students' progressive development towards the achievement of PLOs, in terms of the characteristics that you expect students to demonstrate at the end of each year. This summary may be particularly helpful to students and the programme team where there is a high proportion of option modules.

Note: it is not expected that a position statement is written for each PLO, but this can be done if preferred (please add information in the 'individual statement' boxes). For a statement that applies across all PLOs in the stage fill in the 'Global statement' box.

Stage 0 (if your programme has a Foundation year, use the toggles to the left to show the hidden rows)

Stage 1

On progression from the first year (Stage 1), students will be able to:

Developed core learning strategies for each of the four disciplines studied in Stage 1. Have been introduced to and worked with the core concepts that underpin all three disciplines. Be familiar with the foundational material and practices of each of the four disciplines.

PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
Individual statements							

Stage 2

On progression from the second year (Stage 2), students will be able to:

The more focussed Stage 2 will have further developed the knowledge base of the student, giving them more sophisticated tools with which to address more demanding problems in their two chosen disciplines. Technical facility will be improved by exposure to more advanced concepts.

PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
Individual statements							

Stage 3

(For Integrated Masters) On progression from the third year (Stage 3), students will be able to:	*A Natural Science student specialising in physics will satisfy the Physics Sing. Subj. Statement; "During Stage 3: Effective self-sufficient learners: through the application of core knowledge and techniques to problem solving and interpreting new situations. Have experience in workload planning to enable effective attempts at open-ended or extended investigations (projects or advanced labs). Meet the BSc PLOs for the appropriate programme."*

PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
Individual statements							

Programme Structure

Module Structure and Summative Assessment Map

Please complete the summary table below which shows the module structure and the pattern of summative assessment through the programme.

'Option modue' can be used in place of a specific named option. If the programme requires students to select option modules from specific lists these lists should be provided in the next section.

From the drop-down select 'S' to indicate the start of the module, 'A' to indicate the timing of each distinct summative assessment point (eg. essay submission/ exam), and 'E' to indicate the end of the module (if the end of the module coincides with the summative assessment select 'EA') . It is not expected that each summative task will be listed where an overall module might be assessed cumulatively (for example weekly problem sheets).

If summative assessment by exams will be scheduled in the summer Common Assessment period (weeks 5-7) a single 'A' can be used within the shaded cells as it is understood that you will not know in which week of the CAP the examination will take place.

Stage 0 (if you have modules for Stage 0, use the toggles to the left to show the hidden rows)

Stage 1

Credits	Module		Autumn Term										Spring Term										Summer Term									
	Code	Title	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
20	MAT00007C	Maths for Sciences I	S									EA																				
20	MAT00008C	Maths for Sciences II											S													E	A	A	A			
20	CHE00010C	Chemistry for Natural Sciences I	S					A		A	A		EA																			
20	CHE00012C	Chemistry for Natural Sciences II												S			A	A	A							EA	A	A	A			
20	PHY00022C	Introduction to Thermal & Quantum Physics		S									A									E					A	A	A			
20	PHY00020C	Electromagnetism, Waves & Optics												S												E	A	A	A			
10	PHY00026C	Introduction to Quantum Physics																														
10	BIO00007C	Genetics	S										EA																			
20	BIO00004C	Molecular Biology & Biochemistry	S										A														EA	A	A			

Stage 2

Credits	Module		Autumn Term										Spring Term										Summer Term									
	Code	Title	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
10	MAT00041I	Linear Algebra for Natu	S																			E	A				A	A	A			
10	MAT00030I	Vector Calculus	S										EA																			

10	MAT00024I	Functions of a Complex Variable											S									E				A	A	A				
20	PHY00039I	Thermodynamics & Quantum Physics																														
10	PHY00019I	Physics for Natural Sciences 6: Computational Lab																														
10	PHY00020I	Experimental Laboratory	S									A										EA										
20	PHY00002I	Electromagnetism & Optics												S												E	A	A	A			
10	PHY00037I	Particle & Nuclear Physics																														
10	PHY00040I	Solid State Physics I																														
10	PHY00035I	Mathematics II for Natural Sciences	S										EA																			
10	PHY00033I	Thermodynamics	S										EA																			
10	PHY00036I	Quantum & Atomic Physics II	S										EA																			
30	MAT00036I	Applied Maths Option I	S									A														E	A	A	A			
30	MAT00037I	Applied Maths Option II	S									A														E	A	A	A			
20	BIO000051I	Molecular Biology, Biotechnology & Bioinformatics	S																								EA					
20	BIO000054I	Biochemical Reactions and Interactions	S														A										EA					
20	BIO000011I	Cell Biology	S																								EA					
20	CHE00014I	Chemistry for Nat Sci 3	S						A			A	EA																			
20	CHE00015I	Chemistry for Nat Sci 4												S						A			A	A			EA	A	A			
20	CHE00025I	Chemistry for Nat Sci 5												S													EA	A	A			
Stage 3																																
Credits	**Module**		**Autumn Term**										**Spring Term**										**Summer Term**									
	Code	**Title**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
40	[new]	BSc Project incorporating Prof Skills (BSc only)	**S**																			**E**	**A**									
20	PHY00027H	Advanced Experimental Labs (MSci only from Bio/Phys or Chem/Phys)												**S**								**A**				**EA**						
20	PHY00029H	Advanced Computational Labs (MSci only from Maths/Phys)												**S**								**A**				**EA**						
20	[new]	Statistical Physics and Solid State II	S										A									E					A	A	A			

10	[new]	Quantum Physics III																														
20	[new]	Intro Plasma Sci & Tech and Stellar Physics		S									A													E	A	A	A			
20	[new]	Galaxies and the interstellar medium and Cosmology		S									A									E					A	A	A			
20	[new]	Computational and Math Techniques II (only available if Maths/Phys at stage 2)		S									A									E					A	A	A			
20	[new]	Particle Physics and Relativity												S												E	A	A	A			
20	[new]	Nanoscale and Magnetism												S												E	A	A	A			
20	[new]	Intro to Quantum Computing and ATT		S									A													E	A	A	A			
20	[new]	Atomic Physics & Lasers and Modern Optics		S									A									E					A	A	A			
Stage 4																																
Credits	**Module**		**Autumn Term**										**Spring Term**										**Summer Term**									
	Code	**Title**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
60	PHY00025M	MPhys Project and Research skills	S																										EA			
20	PHY00035M	Advanced Plasma Science and Applications		S									A									E					A	A	A			
20	PHY00032M	Advanced Nuclear Physics		S									A									E					A	A	A			
20	PHY00031M	Advanced Computational Physics		S									A									E					A	A	A			
20	PHY00034M	Nanophysics, Nanomaterials and Nanocharacterisation		S									A									E					A	A	A			
20	PHY00033M	Biophysics		S									A									E					A	A	A			
20	PHY00030M	Advanced and Further Quantum Mechanics		S									A									E					A	A	A			
20	PHY00036M	Light and Matter		S									A									E					A	A	A			

Optional module lists

If the programme requires students to select option modules from specific lists these lists should be provided below. If you need more space, use the toggles on the left to reveal ten further hidden rows.

Option List A	Option List B	Option List C	Option List D	Option List E	Option List F	Option List G	Option List H

Please note: you need to complete information on all three tabs of this sheet before submitting to the UTC Strategy Working Group.

You are required to submit this information for all undergraduate programme by the 31 July 2016.

Programme Map: Module Contribution to Programme Learning Outcomes

Please complete the summary table below which shows how individual modules contribute to the achievement of programme learning outcomes.

Core modules should be mapped individually. If the programme offers multiple options that contribute to exactly the same PLOs you can group these, providing a statement that articulates how all of these contribute to the achievement of the programme learning outcomes. All modules, both core and optional, should be accounted for in the map.

The table maps the contribution to programme learning outcomes made by each module, in terms of the advance in understanding/ expertise acquired or reinforced in the module, the work by which students achieve this advance and the assessments that test it. This enables the programme rationale to be understood:

· Reading the table vertically illustrates how the programme has been designed to deepen knowledge, concepts and skills progressively. It shows how the progressive achievement of PLOs is supported by formative work and evaluated by summative assessment. In turn this should help students to understand and articulate their development of transferable skills and to relate this to other resources, such as the Employability Tutorial and York Award;

· Reading the table horizontally explains how the experience of a student at a particular time includes a balance of activities appropriate to that stage, through the design of modules.

Note: it is not expected that every module contributes directly to all PLOs, but every module should advance some of them.

(Add additional rows as required)

			MSci Programme Learning Outcomes					
			PLO1	PLO2	PLO3	PLO4	PLO5	PLO6

Stage	Module		Apply independent learning strategies that incorporate core and advanced physics, mathematics and/or computational knowledge, techniques and understanding to synthesise and evaluate real-world problems that require expertise in physics.	Plan and execute an extended or complex scientific investigation using the principles of physics in investigating a hypothesis, and interpret outcomes in physical problems.	Work independently and within a research team and apply group-specific research methodologies, including objective analysis and constructive criticism of research level literature, to extended or complex open-ended problems.	Communicate succinctly to the general public, scientists and professional physicists through accurate and precise scientific record keeping, scientific report writing and presentations.	Select and apply sophisticated digital tools for in-depth scientific investigation and in wider societal applications	Use advanced physics principles, themes, concepts and methodologies as appropriate to a Natural Scientist with an understanding of the possibilities that exist to exploit the synergies between physics and other science based disciplines as underpinned by experience and exposure to different scientific disciplines.
			BSc Programme Learning Outcomes					
			PLO1	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**

			Assess and evaluate problems in science, providing solutions through the application of physics, mathematics and/or computational knowledge and techniques.	Construct and execute a scientific investigation using the principles of physics in investigating a hypothesis, and interpret outcomes.	Interact and collaborate effectively within groups applying physics themes and concepts as appropriate for the interdisciplinary nature of a Natural Science degree, to open-ended problems.	Communicate the integration and inter-relation of physics from the perspective of a Natural Scientist with interdisciplinary awareness, present sophisticated concepts and defend outcomes of physical studies succinctly in both written and oral formats to audiences in a logical way.	Use of appropriate digital technologies in data handling and understand the wider applications of these techniques in quantitative science.	Use physics principles, themes, concepts and methodologies as appropriate to a Natural Scientist with an understanding of the possibilities that exist to exploit the synergies between physics and other science based disciplines as underpinned by experience and exposure to different scientific disciplines.
Stage 1	Maths for Sciences I	Progress towards PLO	Develop core mathematics required for Physics applications		Use mathematics to communicate and explain physical phenomena			
		By working on (and if applicable, assessed through)	Exam and assesed homework		Exam and assesed homework			
Stage 1	Maths for Sciences II	Progress towards PLO	Develop core mathematics required for Physics applications		Use mathematics to communicate and explain physical phenomena			

		By working on (and if applicable, assessed through)	Exam and assesed homework		Exam and assesed homework			
Stage 1	Chemistry for Natural Sciences I	Progress towards PLO	Developing an understanding of core chemical principles of atomic structure, thermodynamics, periodicity, acids & bases, separations science & mass spectrometry and reactivity.	Development of core laboratory skills and understanding of key safety practices. Aspects of planning and experimental design and commnunication of results.	Development of core laboratory skills and understanding of key safety practices. Aspects of planning and experimental design and commnunication of results.			Developing an understanding of core chemical principles of atomic structure, thermodynamics, periodicity, acids & bases, separations science & mass spectrometry and reactivity.
		By working on (and if applicable, assessed through)	Exam and assessed workshop	Lab report	Lab report			Exam and assessed workshop
Stage 1	Chemistry for Natural Sciences II	Progress towards PLO	Developing an understanding of core chemical principles of kinetics, thermodynamics, spectroscopy, transition metals and reactivity.	Development of core laboratory skills and understanding of key safety practices. Aspects of planning and experimental design and commnunication of results.	Development of core laboratory skills and understanding of key safety practices. Aspects of planning and experimental design and commnunication of results.			Developing an understanding of core chemical principles of kinetics, thermodynamics, spectroscopy, transition metals and reactivity.
		By working on (and if applicable, assessed through)	Exam and assessed workshop	Lab report	Lab report			Exam and assessed workshop

Stage 1	Introduction to Thermal & Quantum Physics	Progress towards PLO	Solve foundational numerical problems by application of relevant mathematical and physical principles	Gain an understanding of the core importance of quantum mechnics to the science of measurement.				
		By working on (and if applicable, assessed through)	Regular independent assignments (PPQs), small-group problem solving in problem classes, tailored small-group sessions (tutorials), formal examination.	Engaging with teaching materials and links to other modules.				
Stage 1	Electromagnetism, Waves & Optics	Progress towards PLO	Apply problem solving techniques and apply them to weekly problems in an independent way.	Understand that wave mechanics can be used to understand parts of other larger problems beyond those taught explicitly in the course.				

		By working on (and if applicable, assessed through)	Regular independent assignments (PPQs), small-group problem solving in problem classes, examples given in lectures, tailored small-group sessions (tutorials) formal examination.	Engaging with teaching materials.				
Stage 1	Introduction to Quantum Physics	Progress towards PLO	Solve foundational numerical problems by application of relevant mathematical and physical principles	Gain an understanding of the core importance of quantum mechnics to the science of measurement.				
		By working on (and if applicable, assessed through)	Regular independent assignments (PPQs), small-group problem solving in problem classes, tailored small-group sessions (tutorials), formal examination.	Engaging with teaching materials and links to other modules.				

Stage 1	Genetics	Progress towards PLO	By engaging with core principals of classical and molecular genetics that will be built upon in future modules and Stages.	Problem solving exercises to develop understanding of genetics. Students can work individually or in groups.	Gain experience of core techniques such as gel electrophoresis and microscopy			
		By working on (and if applicable, assessed through)	Lectures, pre-recorded material on the VLE, worksheets and set reading. 1 hour closed exam	By multiple pen + paper workshop sessions spread throughout the term. 1 hour closed exam	Three x 3 h practicals			
Stage 1	Molecular Biology & Biochemistry	Progress towards PLO	Gaining an understanding of detailed chemistry and molecular aspects of biology starting from basic chemical building blocks of life to macromolecules and complex biological processes such as metabolism and photosynthesis.	Practicing problem-solving and basic chemistry-based calculations together with hands-on practicals in enzymes kinetics and separation of macromolecules.	Exposure to several basic biochemical techniques (column chromatography, enzyme kinetics) through lectures and practicals.			
		By working on (and if applicable, assessed through)	2 x 1.5-h closed exams (Spring and Summer CAPs)	Open assessment of practical through problem solving. Formative worksheets.	Open assessment of practical through problem solving. Formative worksheets.			

Stage 2	Linear Algebra for Natural Sciences	Progress towards PLO	use the standard methods of basic linear algebra and matrix theory, and their theoretical justification through abstract algebra	apply basic linear algebra and matrix theory to a range of unfamiliar situations	prove standard results in abstract linear algebra		present clear and concise solutions to exercises	
		By working on (and if applicable, assessed through)	lecture material and exercises, with the support of seminars and formative feedback through marked work, and assessed by examination	exercises and with formative feedback through marked work and the seminars, and assessed by examination	lecture material and exercises, with the support of seminars and formative feedback through marked work, and assessed by examination		exercises, with the support of seminars and formative feedback through marked work	
Stage 2	Vector Calculus	Progress towards PLO	use the standard methods of multi-variable differential and integral calculus to work with functions of many variables and vector fields	apply these standard methods to problems which require a level of interpretation to set up the application			present clear and concise solutions to exercises	
		By working on (and if applicable, assessed through)	lecture material and exercises, with the support of seminars and formative feedback through marked work, and assessed by examination	exercises and with formative feedback through marked work and the seminars, and assessed by examination			exercises, with the support of seminars and formative feedback through marked work	

Stage 2	Functions of a Complex Variable	Progress towards PLO	understand and use the standard methods of complex analysis for functions of one complex variable	apply complex analysis to solve problems in applied real analysis, where their use provides quick and powerful solutions	decide when certain methods from complex analysis can, or cannot, be applied and give a justification for this decision		present clear and concise solutions to exercises	
		By working on (and if applicable, assessed through)	lecture material and exercises, with the support of seminars and formative feedback through marked work, and assessed by examination	exercises and with formative feedback through marked work and the seminars, and assessed by examination	lecture material and exercises, with the support of seminars and formative feedback through marked work, and assessed by examination.		exercises, with the support of seminars and formative feedback through marked work	
Stage 2	Thermodynamics & Quantum Physics	Progress towards PLO	Apply and adapt a range of basic tools, models, and physical principles to evaluate physics problems of increasing complexity			Appreciate and be aware of the wider applications of thermodynamics and quantum mechnaics as topics which underpin much of modern physics.		
		By working on (and if applicable, assessed through)	Regular independent assignments (PPQs), small-group problem solving in problem classes, engaging with lecture material, formal examination.			Engaging with teaching materials		

Stage 2	Physics for Natural Sciences 6: Computational Lab	Progress towards PLO	Understand the concept of numerical simulation and use idealised simulations to solve physical problems while accepting the limits of numerical simulation.	develop and run a numerical code to solve real problems	Work independently on longer and more involved computational investigations to achieve a specified result. This is preparation for BSc projects (BSc students) and Stage 3 advanced computational laboratory.	Keep lab book to an accepted and well-defined standard capturing an accurate and comprehensive account of methodologies and results, and effectively communicate results and ideas via formal reports. This is good preparation for the more extended and independent work in Stage 3, in BSc projects (BSc students) or in advanced experimental laboratory (MPhys students).	Learn and apply some more advanced principles and techniques of computational physics. Use digital data manipulation to interpret and present data in graphical form to publishable standards.	Understand and discuss the limitations of simulations and where significant errors arise. Propose improvements for theoretical techniques.
		By working on (and if applicable, assessed through)	Working individually on numerical computation problems.	Conducting lab experiments, writing a formal report; practicals	Working independently to effectively conduct computational investigations.	Writing a formal scientific report, lab book record-keeping for assessment.	Practical, hands-on engagement with methodologies and underlying principles of computational investigations.	

Stage 2	Experimental Laboratory (Physics)	Progress towards PLO	Apply content from lectures modules to conceptually challenging practical situations, while understanding how the choice of methodology and tools governs the reliability of the scientific data collected.	Execute longer and more nuanced experimental investigations	Work effectively with another student on longer and more involved investigations to achieve a specified result. This is preparation for BSc projects (BSc students) and Stage 3 advanced laboratory (MPhys students)	Keep lab book to an accepted and well-defined standard capturing an accurate and comprehensive account of methodologies and results, and effectively communicate results and ideas via formal reports. This is good preparation for the more extended and independent work in Stage 3, in BSc projects (BSc students) or in advanced experimental laboratory (MPhys students).	Proficiently use digital tools, both computer-based (eg LabView, Cassylab) and integrated digital systems (eg digital oscilloscopes) to acquire and analyse experimental data. Use digital data manipulation to interpret and present data in graphical form to publishable standards.	Understand and discuss the implications and limitations of various experimental approaches, with an emphasis on errors

		By working on (and if applicable, assessed through)	Engaging with the underlying theory of experiments carried out. Working in pairs on experiments with pre-defined outputs. Independently writing formal reports for assessment. TP - Working individually on numerical computation problems.	Conducting lab experiments, writing a formal report; practicals	Working in pairs and independently to effectively conduct practical work.	Writing a formal scientific report, lab book record-keeping for assessment.	Practical, hands-on engagement with methodologies and underlying principles of both experimental and computational investigations.	Discussion of experiment in assessed laboratory notebooks, discussion in formal reports.
Stage 2	Electromagnetism & Optics	Progress towards PLO	Use a range of mathematical tools and physical principles to evaluate physics problems of increasing complexity. Understand the wide-ranging applicability of electromagnetism to solving problems from a variety of other fields of physics and beyond.					

		By working on (and if applicable, assessed through)	Regular independent assignments (PPQs), small-group problem solving in problem classes, engaging with lecture material, formal examination.					
Stage 2	Particle & Nuclear Physics	Progress towards PLO	Adapt and apply the principles of particle & nuclear physics to describe and predict the behaviour of fundamental particles.					
		By working on (and if applicable, assessed through)	Regular independent assignments (PPQs), independent supported problem solving in problem classes, engaging with lecture material, formal examination.					

Stage 2	Solid State Physics I	Progress towards PLO	Apply and adapt a range of basic tools, models, and physical principles to evaluate physics problems of increasing complexity			Appreciate and be aware of the wider applications of solid state physics as a topic which underpin much of modern physics.		
		By working on (and if applicable, assessed through)	Regular independent assignments (PPQs), small-group problem solving in problem classes, engaging with lecture material, formal examination.			Engaging with teaching materials		

Stage 2	Mathematics II for Natural Sciences	Progress towards PLO	Be able to select and apply a range of mathematical tools to evaluate suitable physics problems. Understand the foundational importance of mathematics in the study of physics and physical systems. Vector calculus component feeds very strongly into Stage 2 Electromagnetism and Optics (EMO).					
		By working on (and if applicable, assessed through)	Regular independent assessed assignments (PPQs), engaging with lecture material, independent suported problem-solving sessions (maths practicals), formal examination.					

Stage 2	Applied Maths Option I	Progress towards PLO	Apply a range of mathematical concepts to solve applied maths problems relevant to physics		present clear and concise solutions to exercises using mathematical and physical arguments			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the support of seminars and formative feedback through marked work, and assessed by examination		exercises, with the support of seminars and formative feedback through marked work			
Stage 2	Applied Maths Option II	Progress towards PLO	Apply a range of mathematical concepts to solve applied maths problems relevant to physics		present clear and concise solutions to exercises using mathematical and physical arguments			
		By working on (and if applicable, assessed through)	lecture material and exercises, with the support of seminars and formative feedback through marked work, and assessed by examination		exercises, with the support of seminars and formative feedback through marked work			

Stage 2	Chem for Nat Sci 3	Progress towards PLO	Developing an understanding of advanced chemical principles of retrosynthetic analysis, solutions and mixtures, symmetry and group theory, organic synthesis with enolate equivalents, metal-ligand and metal-metal bonding, coordination chemistry and quantum mechanics.	Develop intermediate skills required for synthetic inorganic and organic chemistry including handling air and water-sensitive materials and pyrophorics. Working safely in the laboratory	Develop intermediate skills required for synthetic inorganic and organic chemistry including handling air and water-sensitive materials and pyrophorics. Working safely in the laboratory			Developing an understanding of advanced chemical principles of retrosynthetic analysis, solutions and mixtures, symmetry and group theory, organic synthesis with enolate equivalents, metal-ligand and metal-metal bonding, coordination chemistry and quantum mechanics.

		By working on (and if applicable, assessed through)	Examination	Experiments within the Advanced synthesis practical. Safety lecture course and assessment highlights good working practice. Core and advanced laboratory skills are formatively assessed during the Skills exercise then summatively assessed on a weekly basis principally through in-lab assessments during the first half of term.	Experiments within the Advanced synthesis practical. Safety lecture course and assessment highlights good working practice. Core and advanced laboratory skills are formatively assessed during the Skills exercise then summatively assessed on a weekly basis principally through in-lab assessments during the first half of term.			Examination

Stage 2	Chem for Nat Sci 4	Progress towards PLO	Developing an understanding of advanced chemical principles of vibrational specroscopy, excited states and photochemistry, physical organic chemistry, organometallic chemistry, photoelectron spectroscopy and molecular orbital theory and heteroaromatic chemistry.	Design and perform experiments	Design and perform experiments			Developing an understanding of advanced chemical principles of vibrational specroscopy, excited states and photochemistry, physical organic chemistry, organometallic chemistry, photoelectron spectroscopy and molecular orbital theory and heteroaromatic chemistry.
		By working on (and if applicable, assessed through)	Examination	Physcial organic chemistry lab / physical chemistry labs	Physcial organic chemistry lab / physical chemistry labs			Examination
Stage 2	Chem for Nat Sci 5	Progress towards PLO	Developing an understanding of fundamental chemical principles of solid state chemistry, substitution and elimination and alkenes and alkynes.	Development of core laboratory skills and understanding of key safety practices. Aspects of planning and experimental design.	Development of core laboratory skills and understanding of key safety practices. Aspects of planning and experimental design.	Developing professional modes of behaviour, with respect to sharing resources, learning and adhering to standard laboratory practice, and working well with others		Developing an understanding of fundamental chemical principles of solid state chemistry, substitution and elimination and alkenes and alkynes.

		By working on (and if applicable, assessed through)	Examination	Team project work through Integrated Chemistry Practical (ICP). A mixture of mainly formative assessments (training) and selected summative assessments (proof of competence) drive the learning of key laboratory skills. Design of an experimental investigation applying analytical chemistry techniques is guided by laboratory staff and summatively assessed at the conclusion of ICP.	Team project work through Integrated Chemistry Practical (ICP). A mixture of mainly formative assessments (training) and selected summative assessments (proof of competence) drive the learning of key laboratory skills. Design of an experimental investigation applying analytical chemistry techniques is guided by laboratory staff and summatively assessed at the conclusion of ICP.	Group experiments in the integrated chemistry practicals and by working on practical experiments individually, in pairs, and in small groups; creative approaches to research strategy; summative assessment (ICP) involves team presentations.		
Stage 2	Cell Biology (20c)	Progress towards PLO		Design and perform experiments to investigate mechanisms underlying cell motility.	Group work in laboratory practicals and workshops to understand cell biology.			Integration of acquired understandings of cell biology principles and pathophysiologies. Logical thinking/crtitical analyses/ problem solving skills.

		By working on (and if applicable, assessed through)		Workshops and practicals. Assessed through a closed assessment.	Workhops and practicals. Assessed through a closed assessment.			Lectures, workshops and practicals. Assessed through a closed assessment.
Stage 2	Biochemcial Reactions and Interactions	Progress towards PLO		Design experiments applying advanced analytical and quantitative techniques to address biological questions. Analyse multi-parameter data sets generated by these techniques and interpret in the context of a research hypothesis.	Group work in problem-solving workshops to understand key concepts underlying techniques, their limitations and their applications in biochemical research.			Select an appropriate set of techniques to address a research question, then analyse and interpret the data acquired using these techniques. Gain an appreciation of the wider applicability of core biochemical and biophysical techniques in cross-disciplinary research through engagement with the published literature.

		By working on (and if applicable, assessed through)		Design experiments to address biochemical and biophysical problems in formative workshops. Critical analysis of research articles in workshops. Assessed by 1.5 hr closed (open note) workshop in middle of Spring term.	Formative problem-solving activities in workshops and structured independent learning (engagement with 'flipped' lecture material).			By applying numerical and quantitative skills in biochemical and biophysical problem-solving activities in formative workshops with opportunities to apply R. Critical analysis of research articles in workshops. Numerical and quantitative skills assessed by summative workshop-based exam.
Stage 2	Molecular Biology, Biotechnology & Bioinformatics	Progress towards PLO		First hand execution of practical and analysis of quantitative transcriptomics data.	Biological problems presented in a range of workshops with different formats where students will work alone or in different sized groups.		Understanding methods associated with transciptomics, manipulating and interpreting this type of data using bioinformatics skills.	
		By working on (and if applicable, assessed through)		Practicals	Practicals and workshops. Understanding and problem solving ability assessed in workshops. All blocks		All workshops and or practicals which involve some of the transferable skills listed above	

Stage 2	Genes, Genomes, Evolution & Population	Progress towards PLO		A major focus will be on the interpretation of data and some modelling approaches.	Individual and group problem-solving	Discussing module related topics in workshops with peers and instructors. Participation in VLE discussion board.		
		By working on (and if applicable, assessed through)		Workshop on modelling selection and interpreting outcomes. Interpreting outcomes of genome wide analyses.	workshops focussing on population genetic principles, using simple models. Workshop on altruism, and workshop on macroevolution.	Workshops, participation in VLE discussion forum		
		By working on (and if applicable, assessed through)		Lab practicals and associated workshops, algorithm workshop, field practical	Praciticals, workshops, exam and open assessment	Algorithm workshop presentations	practicals, workshops	

		Progress towards PLO	Use physics knowledge and understanding to pursue a (group) scientific investigation of independent choice.	Plan and execute a complex scientific investigation, including understanding the context of the problem by accessing current literature and using appropriate techniques.	Work effectively as part of a group to plan and execute a solution to an extended and open-ended physical problem.	Concisely and clearly communicate the background to and results of an extended research-style scientific investigation orally to peers in a large group, examiners in a viva-style examination, and in formal dissertation writeup. Keep accurate record of all experimental and theoretical work to accepted standards. Articulate how working on a specific physics problem provides experience and expertise that can be applied to broader range of situations.	Apply previously learned and new digital approaches and techniques to unfamiliar problems, and understand that a digital approach can be useful beyond the bounds of pure physics.	Select and apply as appropriate a range of appropriate experimental and analytical tools, techniques, and methodologies to make experimental measurements while minimising systematic and random errors as part of a larger research project, and make critical judgements on the effects of these techniques upon the quality and fidelity of the final result.

Stage 3	BSc Project incorporating Prof Skills	By working on (and if applicable, assessed through)	Completion of the BSc Project work, examined through formal report, assessment of project lab book, and oral (viva-style) exam.	Planning, managing and executing the project work with support from project supervisors where appropriate	Working as a group to achieve a common goal and reviewing and assessing current literature on your topic.	Presenting a group oral presentation at the BSc project conference, individual oral viva-style defence and examination, formal written dissertation, examination of laboratory notebook.	Engaging with BSc project work and exploring the digital approaches that can advance the project.	Planning, executing and evaluating project work with support from project supervisors where appropriate. A presentational aspect to the project will be built in on a project day, where students will be tasked to present the findings of their research to their peers across their cohort. To enable students from different disciplines to understand their presentation, a student will need to appreciate th inter-disciplinary aspects of their subject and be able to effectively communicate to a general audience.

Stage 3	Advanced Experimental Labs (Core M)	Progress towards PLO	Experience how appropriate design and methodologies lead to reliable and repeatable scientific investigations. Experience and elucidate how the changing of parameters on a physical system can lead to different qualitative and quantitative outcomes.	Investigate an area of experimental or computational physics in a systematic way using appropriate experimental or computational techniques. Search and review the scientific literature to understand current approaches the problems addressed in the labs.	Collaborate effectlively with partners and, where applicable, interact with other groups and staff in the course of extended, complex experiments.	Reporting on a research strength of the department through an essay and press release. Communicate complex experimental outcomes in a formal written report, and record accurately all experimental activity in an accepted form.	Adapt and apply appropriate research-level compter-based techniques for data analysis, equation solving and/or simulation	Creatively select and apply as appropriate a wide range of appropriate advanced experimental and analytical tools, techniques, and methodologies to make specific experimental measurements, and make critical judgements on the effects of these techniques upon the quality and fidelity of the final result. This will feed directly into MPhys project work.
		By working on (and if applicable, assessed through)	Engagement with practical or computational experiments and the analysis of measurements	Completing open-ended experimental or computational activities in laboratory sessions.	Working in pairs on complex experiments, often using research-grade equipment, consulting scientific literature when necessary.	Assessed essay and press release. Engage in a thorough literature survey, summarise and report on the oucomes of the survey. Formal assessed dissertation and assessed laboratory notebooks.	Engaging with the experimental work and underlying theory of experiments carried out in laboratory sessions.	Completing open-ended experimental activities, assessed through laboratory notebooks and formal written reports.

Stage 3	Advanced Computational Labs (Core M)	Progress towards PLO	Experience how appropriate design and methodologies lead to reliable and repeatable scientific investigations. Experience and elucidate how the changing of parameters on a physical system can lead to different qualitative and quantitative outcomes.	Investigate an area of experimental or computational physics in a systematic way using appropriate experimental or computational techniques. Search and review the scientific literature to understand current approaches the problems addressed in the labs.	Collaborate effectlively with partners and, where applicable, interact with other groups and staff in the course of extended, complex experiments.	Reporting on a research strength of the department through an essay and press release. Communicate complex experimental outcomes in a formal written report, and record accurately all experimental activity in an accepted form.	Adapt and apply appropriate research-level compter-based techniques for data analysis, equation solving and/or simulation	Creatively select and apply as appropriate a wide range of appropriate advanced experimental and analytical tools, techniques, and methodologies to make specific experimental measurements, and make critical judgements on the effects of these techniques upon the quality and fidelity of the final result. This will feed directly into MPhys project work.
		By working on (and if applicable, assessed through)	Engagement with practical or computational experiments and the analysis of measurements	Completing open-ended experimental or computational activities in laboratory sessions.	Working in pairs on complex experiments, often using research-grade equipment, consulting scientific literature when necessary.	Assessed essay and press release. Engage in a thorough literature survey, summarise and report on the oucomes of the survey. Formal assessed dissertation and assessed laboratory notebooks.	Engaging with the experimental work and underlying theory of experiments carried out in laboratory sessions.	Completing open-ended experimental activities, assessed through laboratory notebooks and formal written reports.

Stage 3	Statistical Physics and Solid State II	Progress towards PLO	Understand the underlying energy distribution of systems containing many particles. Understand the different models involved describing the electron-electron and electron-lattice interactions in solids.					
		By working on (and if applicable, assessed through)	Regular independent assignments (PPQs), independent supported problem solving in problem classes, engaging with lecture material, formal examination.					

Stage 3	Quantum Physics III	Progress towards PLO	Adapt and apply the tools of quantum mechanics to build and test foundational models of atomic and nuclear systems. Interpret modern atomic and nuclear data in terms of sub-atomic phenomena.	Design experiment using specific observables to identify specific phenomena	Take a collaborative approach to solving problems in quantum mechanics, and achieve a deeper understanding of advanced concepts in nuclear physics through discussion with peers.	Articulate the central importance of quantum mechanics to modern physics and the application of nuclear physics to society.		
		By working on (and if applicable, assessed through)	Regular independent assignments (PPQs), independent supported problem solving in problem classes, engaging with lecture material, formal examination.	Analysis of nuclear data in lectures and problem classes, identification of key observables	Engaging with the group-work aspect of problem classes.	Enagaging with lecture materials and some problem questions		

Stage 3	Intro Plasma Sci & Tech and Stellar Physics	Progress towards PLO	Adapt and apply concepts and techniques to independently solve increasingly complex problems in plasma and stellar physics			Learn and be able to describe key plasma physics and behaviour, including plasma fusion. Understand the relevence of plasma science to matters of clean energy and energy security. Appreciate how plasma physics can aid in the understanding and interpretation of astrophysical systems. Understand the wider implications of plasma fusion.		
		By working on (and if applicable, assessed through)	Regular independent assignments (PPQs), independent supported problem solving in problem classes, engaging with lecture material, formal examination.			Engaging with teaching materials, formal examination.		

Stage 3	Galaxies and the interstellar medium and Cosmology (Core AP)	Progress towards PLO	Adapt and apply experimental techniques to solve a wide range of astrophysical problems and explain astrophysical phenomena		Discuss with others to develop routes to solutions of complex problems associated with the ISM and cosmology.	Discuss how the principles of astrophysical research are applicable to a range of physics problems.		Explore and understand the strengths and limitations of a physics approach to the interpretation of astronomical data. Use this understanding to analyse real and simulated data and discuss the results.
		By working on (and if applicable, assessed through)	Participating in workshops with extended data analysis problems, formal examination.		Participating in problem classes/workshops - space for individual, paired and group work.	Participatingin problem classes/workshops - space for individual, paired and group work.		Participating in workshops in analysing real and simulated astronomical data from a range of different sources.
Stage 3	Computational and Math Techniques II	Progress towards PLO	Independently adapt and apply computational and mathematical techniques to solve complex physical problems.	Plan and implement complex scientific investigations using principles of computational physics		Present results of an independent computational investigation accurately and precisely for a target audience of physicists.	Implement an algorithm for simulating molecular behaviour based upon physical principles, and appraise how the results of such simulations can have applications in a variety of contexts.	Plan and execute a theoretical investigation drawing upon a range of techniques and approaches, and evaluate the correctness and limitations of computational methods.

	(Core TP)	By working on (and if applicable, assessed through)	Regular independent assignments (PPQs), engaging with lecture material, large independent assignment, formal examination.	Writing computer programs		Writing a formal research report for the molecular simulation component of the module.	Engaging with teaching materians, writing formal summative report.	Using computer programs to investigate physical systems, both in supported practical computer lab sessions and in independent assignments for assessment.
Stage 3	Particle Physics and Relativity	Progress towards PLO	Adapt and apply the principles of relativistic and non-relativistic quantum physics to describe and predict the behaviour of fundamental particles.			Understand and articulate the current state of knowledge about a particular aspect of a topic covered in lectures. Conduct a literature review on an area of the course chosen from a list, presenting and evaluating information from a range of research papers in a succinct and readable written form. This is good preparation for MPhys project work (MPhys students only).		

		By working on (and if applicable, assessed through)	Regular independent assignments (PPQs), independent supported problem solving in problem classes, engaging with lecture material, formal examination.			Writing literature review/essay for summative assessment.		
Stage 3	Nanoscale and Magnetism	Progress towards PLO	Adapt and apply core and more advanced physics concepts to new and familiar situations. Compare the suitability of differing measurement techniques for different types of sample/measure ment.	Understand the origin of contrast and resolution, and hence be able to design an appropriate scientific investigation on the relevant length scales and beyond.		Describe and evaluate concepts in magnetism and measurement techniques clearly, quantitatively, and succinctly for a scientific audience. Understand the uses of nanoscale analysis techinques throughout a range of fields of physics and beyond.		Discriminate between and appropriately select techniques for both imaging and magnetic measurement.

		By working on (and if applicable, assessed through)	Regular independent assignments (PPQs), engaging with lecture material, formal examination, open-book magnetism assignment.	Interpreting images from different microscopy techniques and calculating the associated errors. Discussing different magnetic measurement techniques in lectures. Assessed in essay format.		Open-book, independent assignments, writing for a scientific audience. Researching and writing solutions to an open-book summative assignment.		Interpreting images from different microscopy techniques and calculating the associated errors. Discussing different magnetic measurement techniques in lectures. Assessed in essay format.
Stage 3	Intro to Quantum Computing and ATT	Progress towards PLO	Adapt and apply sophisticated theoretical and mathematical tools, including quantum algorithms, integral and general linear transformations, to solve unseen problems across many fields of physics.		Understand and be able to apply key mathematical techniques for theoretical and mathematical physics to a range of increasingly complex physical problems.		Exploit the links between quantum mechanics and quantum computing to understand the potential benefits of quantum computing when applied to certain mathematical and physical problems.	

		By working on (and if applicable, assessed through)	Regular independent assignments (PPQs), independent supported problem solving in problem classes, engaging with lecture material, formal examination.		Engaging with teaching material.		Engaging with teaching materials.	
Stage 3	Atomic Physics & Lasers and Modern Optics	Progress towards PLO	Adapt and apply concepts and mathematics to independently solve unfamiliar problems in atomic physics, laser physics, and modern optics	Use demonstrations to show various optical phenomena, interpret the results	Use a mathmatical approach to predict the diffraction pattern for a range of foundational optical systems.	Become aware of the applications of optics in a range of scientific and consumer applications and how thse applications depend upon atomic physics/laser physics/modern optics.	Understand how modern digital image capture, analysis, and manipulation can be used to make optical measurements which would otherwise be unfeasible.	
		By working on (and if applicable, assessed through)	Regular independent assignments (PPQs), independent supported problem solving in problem classes and in closed examination.	Engaging with lecture content.	Engaging with teaching material.	Engaging with teaching materials.	Engaging with teaching materials.	

Stage 4	MPhys Project and Res Skills	Progress towards PLO	Creatively apply independent learning strategies to tackle new research questions and/or unfamiliar problems in specialised areas of physics, interpreting and presenting results in an appropriate manner. Independently identify relevant data, methodologies, and approaches from a wide body of research literature, and incorporate them into project work as and when appropriate. Understand that a physics approach can be immensely powerful when applied to a vast range of problems.	Carry out independent research, access and use current literature and identify the most suitable approach to tackle a specific research question.	Work independently as part of a research group on a complex and open-ended research project incorporating methodologies and approaches garnered both from academic literature and from research groups here in York. Write a final report including critical appraisal of published data, results, and conclusions in the light of the outcomes of the research project.	Concisely, clearly, and comprehensively communicate the background, theory, methodology, and results of an advanced extended scientific investigation orally to peers in a large group, examiners in a viva-style defence, in formal dissertation writeup, and in a conference poster. Defend the poster before conference attendees (peers, research students, and academics). Keep accurate record of all experimental and theoretical work to accepted standards. Be able to articulate how a specific physics problem fits into the broader picture of our understanding of nature.	Show and articulate how a specific digital approach applied to a physics problem fits into the broader picture of our understanding of nature. Apply previously learned digitial approaches and techniques to unfamiliar problems, and understand that a physics approach can be immensely powerful when applied to a vast range of problems. Be inspired by the power of digital techniques through project work in an area of choice and conduct an extended independent investigation using it.	Carry out novel research, including experimental/computational design, appropriate selection of data acquisition/generation and analysis techniques, analysis, evaluation, and appraisal of the results obtained in the context of the strengths and limitations of the methodology used.

		By working on (and if applicable, assessed through)	Completing independent project work, with support from project supervisor(s) as appropriate.	Planning and executing an independent research project, evaluating the data in relation to a hypothesis or hypotheses and the current status of the field and presenting results in formal written and oral formats.	Working both independently and as part of a wider group to produce research-level output incorporating all aspects of this PLO. Refining ability to search for and assess appropriate scientific literature.	Preparing research materials for dissemination in written form (e.g. in laboratory note books, dissertations), oral form (e.g. supervisor discussion, seminar, viva) and via other presentations (e. g. to supervisors and during the summer conference).	Enaging in project work, exploring within the project which tools are most effective in delivering results.	Working on research project design, realisation, and follow-up. Examined through formal written report and oral viva-style examination. A presentational aspect to the project will be built in on a project day, where students will be tasked to present the findings of their research to their peers across their cohort. To enable students from different disciplines to understand their presentation, a student will need to appreciate th inter-disciplinary aspects of their subject and be able to effectively communicate to a general audience.

Stage 4	Adv Plasma Science and Applications	Progress towards PLO	Creatively apply independent learning strategies incorporating core and advanced physics to understand and evaluate real-world plasma physics of relevance to inertial and magnetic fusion and astrophysics. Understand key plasma physics concerns behind both inertial and magnetic confinement approaches to fusion and basic plasma behaviour. Understand the relevence of plasma science to matters of clean energy and energy security.		Work both independently and collaboratively in order to explore complex problems involving terrestrial and astrophysical plasmas.	Through deep understanding, communicate the key plasma physics issues behind realising inertial and magnetic confinement approaches to fusion and basic plasma behaviour. Understand the relevence of plasma science to matters of clean energy and energy security. Appreciate how plasma physics knowledge - aquired and tested in terrestrial setting - is used to understand and interpret astrophysical systems.	Computational techniques are central to plasma physics, because the study of collective processes in many-body charged-particle systems are quite intractible to calculate by hand.	

		By working on (and if applicable, assessed through)	Regular independent assignments, engaging with teaching materials and problem class material, formal examination.		Regular assignments and engaging with problem class material.	Engaging with teaching materials, formal examination.	Engaging with teaching materials; private study time.	
Stage 4	Adv Nuclear Physics	Progress towards PLO	Creatively apply independent learning strategies that incorporate core and advanced physics to evaluate real-world nuclear physics and astrophysics problems Understand the wider role of nuclear physics in the cosmos, and the power of small scale interactions to shape the universe.	Evaluate and analyse third-party data.	Work independently and within a research team to deliver thorough and complete solutions to complex exercises and assignments	Communicate advanced nuclear physics concepts via report writing and presentations		Evaluate sophisticated experimental measurements to evaluate nuclear physics and astrophysics models.
		By working on (and if applicable, assessed through)	Regular independent assignments, engaging with lecture and problem class material, formal examination.	Applying the principles of nuclear physics and astrophysics to evaluate third-party published data	Engaging with group-work aspect of problem classes and assignments.	Engaging with lectures, problem classes and assignments		Engaging with teaching material, working on independent assignment.

Stage 4	Adv Computational Physics	Progress towards PLO	Apply independent learning strategies to implement complex computational methods for the simulation of advanced physical problems, eg fast fourier transforms, parallel code etc	Plan and execute a computational scientific investigation using advanced parallel computing techniques including MPI, OpenMP, and CUDA. Compare and contrast different computational approaches to the same problem, including comparison of different compilers and programming paradigms.	Work independently and as a team implementing complex algorithms and applying them to extended and complex problems		Independently write complex pieces of code in a highly optimised way, to run on a particular target architecture (GPGPU etc). Critically assess different computational methods and their appropriateness for different physical problems, understanding the consequences of choosing poor methods upon the outcome. Demonstrate the power of computation to solve problems an predict physical behaviour.	Learn, modify, and apply a range of advanced computational techniques to modelling physical systems while considering their limitations.

		By working on (and if applicable, assessed through)	Participating in practical programming classes developing computational techniques, engaging with lecure material, formal examination.	Developing a high performance computer code to investigate the properties of a modelled system	Participating in supported lab sessions (practicals), and completing two long, complex, and open-ended computational assignments.		Engaging with teaching materials. Formally assessed via independent assignment.	Engaging with teaching material, participating in supported lab sessions (practicals), and completing two long, complex, and open-ended computational assignments.

Stage 4	Nanophysics, Nanomaterials and Nanocharacterisation	Progress towards PLO	Creatively use advanced physics concepts to evaluate given physical world questions Understand key physics phenomena underpinning the development of advanced experimental techniques used in Physics research. Appraise the suitability of different nanofabriacation and nanomanipulation techniques for the solution of a specific problem	Use advanced physics concepts to investigate complex physics problems.	Engage with the scientific literature to identify the most suitable methodology to solve a complex nanophysical problem.	Summarise complex research ideas to a professional audience in written form. Acquire and summarise in-depth knowledge and understanding of key physics phenomena underpinning the development of advanced 'nano' techniques research. Appraise and advise on the suitability of different nanofabriacation and nanomanipulation techniques for the solution of a specific problem. Appreciate the benefits and drawbacks associated with consumer products based on nanomaterials.		Produce an in-depth investigation on a particular topic identifying or designing the best methodology with which to approach a given physics problem.

		By working on (and if applicable, assessed through)	Engaging with lecture and problem class material. Formal examination.	Participating in problem classes.	Completing an independent research-based assignment for formal assessment.	Completing formally examined written assignment.		Completing formally examined written assignment.
Stage 4	Biophysics	Progress towards PLO	Creatively adapt and apply core and advanced physics concepts to new situations.		Solve complex problems, partly working in a group within a small-group teaching environment.	Appreciate that physical principles are used to solve familiar and unfamilar problems related to biological systems. Communicate how a physics approach can be immensely powerful to solving problems from disparate fields of research.		
		By working on (and if applicable, assessed through)	Regular independent assignments, engaging with lecture material. Formal examination.		Working in groups in problem classes.	Engaging with teaching materials and working in groups to discuss problems		

Stage 4	Adv and Further Quantum Mechanics	Progress towards PLO	Creatively adapt and apply core and advanced physics concepts to new situations.		Solve complex problems independently and during interactive problem classes.	Articulate the central importance and immense power of quantum mechanics. Understand and utilise the concepts of QM when discussing physical measurements and their reproducibility and accuracy.		
		By working on (and if applicable, assessed through)	Regular independent assignments, engaging with lecture material. Formal examination.		Working in groups in problem classes.	Engaging with teaching materials.		
Stage 4	Light and Matter	Progress towards PLO	Develop expert knowledge and high-level understanding of semiconductors, lasers and light-matter interactions and their application to specific complex real-world physics problems		Develop expert knowledge and high-level understanding of semiconductors and their application to specific complex real-world physics problems	Articulate the behaviour of semiconductors, lasers and light matter interactions and the limitations of the approaches used.		

		By working on (and if applicable, assessed through)	Engaging with lecture and problem class material. Formal examination.		Working in groups in problem classes.	Engaging with teaching materials	.	

Programme Map: Module Contribution to Programme Learning Outcomes

The information provided in this section should make clear why the students are doing the key activities of the programme, in terms of reaching the PLOs. You should use this section to provide commentary on the programme map and how current practice effectively propels student learning. Please indicate any changes that you plan to make to the programme linked to the pedagogic principles.

This section should capture reflections on the programmes and areas for development linked to the principles of the York pedagogy. Please provide an explanation of the programme and assessment design with reference to future enhancements aligned with the pedagogic principles.

Contact with staff
Please explain how the programme's design maximises the value of students' contact time with staff (which may be face-to-face, virtual, synchronous or asynchronous), including through the use of technology-enhanced learning. An example might be giving students resources for their independent study which then enables a class to be more interactive with a greater impact on learning.

You should include:

i. An explanation of how contact with staff in the future programme will be designed to propel student learning

The vast majority of the programme is made up of modules from the Department of Physics. Therefore the relevant statements made in that department's respective submissions apply here. Note is also made to refer to the Biol & Chem & Maths YP single subject documentation due to the splits in Stages 1 and 2.

ii. Changes to the existing programme that will be explored to affect this change; make references to the map to include module level change.

Some changes are expected due to the rollout of the YP in Biol & Chemistry. The Maths & Phys rollouts have already begun and have been incorporated into the current programme. Further changes will roll out in concert with those of Phys. All courses, this one included, are reviewed annually and feedback will be given to all contributing departments. Any further changes that may be necessary will naturally arise during this constant process of review.

Students' independent study and formative work **Please outline key features of how independent study and formative work has been designed to support the progressive achievement of the programme learning outcomes. (For example, the use of online resources, which may also incorporate formative feedback; opportunities for further learning from work-based placements).** **You should include:**
i. An explanation of how students' independent study and formative work has been designed in the future programme to propel student learning?
Again, we refer to the corresponding statements in the Biol, Chem & Maths enhancement plans for the reasons stated above.
ii. Changes to the existing programme to affect this change; make reference to the programme map to indicate module level change
Changes due roll out of the YP will be phased as they occur in the single subject rollout. Any changes will be phased in as and when they happen in the single subject degrees. Reference is made to the corresponding statements in the Bio, Chem & Maths enhancement plans. Due to the nature of all our specialisation programmes and the fact that the learning and teaching in Stages 1 & 2 is spread across multiple departments, there may be bottle necks for the students in terms of assessment. Currently this is handled on a report to the BoS basis and then escalted outwards after a BoS meeting to the Departments. This is a challenge for Natural Sciences and and a definite enhancement to the programmes will be some way of monitoring and controlling these bottlenecks. Currently the YP doesn't help as its level of detail is module assessment and that we have more control over. Its the intra-module assessment. We will carry on investigating ways in which we can manage this issue effectively for our students. One thing that we have not yet being able to do is use any NSS returns to identify issues or good practice as we have yet to have a graduating cohort. Once this data comes in then we will of course incorporate the outcomes into our annual review processes.
(c) Summative Assessment **Please outline how summative assessment within and across modules has been designed to support and evidence the progressive achievement of the programme learning outcomes. (For example, the use of different assessment methods at the 'introduction' stage compared to those used to evaluate deeper learning through the application of skills and knowledge later in the programme).** **You should include:**
i. An explanation of how formative and summative assessment has been designed in the future programme to propel student learning?

As in Item 5; Nat Sci honours the pedagogical practices of our contributing departments whenever possible and this is certainly the case in summative assessment. The vast majority of the programme is built on modules from the single subject diet and the assessment modes used are judged best to assess the various learning outcomes on these modules.

ii. Changes to the existing programme to affect this change; make reference to the programme map to indicate module level change

As for item 12.

The final year project is a major component of all our degrees and is a chance for our students to show not only their skills and ability in a specialisim, but also to work in their specialism on a project that is interdisciplinary. Indeed this is seen at the most natural place to assess any PLOs which emphasise interdisciplinarity. The full process of running projects is currently under review and any changes/improvements will be incorporated into the programmes.

We need to figure out how to faithfully capture the interdisciplinarity of the programme when a lot of it isn't assessed e.g.
(a) the intentional juxtaposition of modules from different departments that cover complementary/similar topics
(b) Natural Sciences hour
The latter is especially important as its a unique feature of the Nat Sci programmes.

Support with implementing programme enhancements

Support services will be able to provide guidance on enhancing programmes for example changing assessment and feedback practice, developing students' digital literacy capabilities and technology enhanced learning, employability etc. Please indicate in the space below if you would like additional guidance to implement you enhancements and what support you would require. For more information on the types of support that is available across the University please see the website:

https://www.york.ac.uk/staff/teaching/support/

Infrastructure: we look forward to the creation of a fully-functional programme & module catalogue which will enable:

- the efficient sharing of information between departments (& the ASO) e.g. module changes
- the shared usage of information for a variety of purposes (e.g. programme specs, admissions materials, student handbooks, website, ...)
- identification of issues like assessment bottlenecks & student workload

Nat Sci would like to give a particular note of thanks to David Gent, Cecillia Lowe, Katy Mann Benn & colleagues for their support when compiling this documentation and undergoing the process of making our programmes YP compliant. Their input has been invaluable.